CHAPTER 14
SWIMMING POOL HEATING

14-1. GENERAL.

A swimming pool is a type of energy storage area with heat gains and heat losses occurring continuously. The amount of energy in the pool at any time is determined by the temperature of the pool. Heat gains from sunlight absorbed directly by the pool and from heaters either conventional, solar or both increase water temperature. Heat losses to the sky, to the surrounding air, and to the ground decrease pool temperature.

14-2. SOURCES OF HEAT GAIN AND LOSS.

Pool water becomes colder when energy is withdrawn through heat losses. Heat losses occur primarily at the surface of the water through evaporation, conduction and convection, and thermal radiation. Relatively little heat is lost to the ground.

14-3. EVAPORATIVE LOSSES.

These heat losses occur when the water at the surface of the pool is changed into vapor and carried away in the air. Besides decreasing the pool temperature, evaporation also results in significant loss of water and pool chemicals. Evaporation is increased by high windspeeds, high pool water temperature, high air temperature, and low relative humidity.

14-4. CONDUCTION AND CONVECTION LOSSES.

These losses are closely linked with evaporative losses and occur when heat from the pool surface is transferred to the cooler surrounding air. Conduction and convection losses increase with high windspeeds, low outside air temperatures, and high pool temperature.

14-5. THERMAL RADIATION.

Radiant heat losses occur when a warm pool radiates heat directly into the cooler sky, and account for about 30 percent of the heat lost from pools. These losses increase when the sky is clear, the relative humidity is low, and the pool temperature is high.

14-6. HEAT LOSSES TO THE GROUND.

The ground is a good insulator, so heat losses for an in ground pool comprise less than 10 percent of total lost energy. The typical above-ground pool with a vinyl liner and exposed sides has additional losses.

14-7. SWIMMING POOL HEAT GAINS.

a. Swimming pools are heated naturally through sunlight that is absorbed directly into the water and by the sides and bottom of the pool. Additional heat can be supplied by either solar, fossil fuel, or electric heaters.

b. The amount of sunlight absorbed by a pool is determined by the amount of sunlight reaching the pool surface multiplied by the fraction of light the pool actually absorbs. Such factors as location, time of year, and amount of shading control the amount of sunlight available to a pool.

c. The sunlight that is not absorbed by the water is reflected from the surface, sides, and bottom of the pool. Typically, about 10 percent of the sunlight reaching the pool is reflected rather than absorbed. Most of the reflection, however, occurs at the surface of the water—about 7 percent annually. The amount of sunlight reflected from the sides and bottom of the pool is small, because much of the light has been absorbed by the water.

14-8. POOL TEMPERATURE.

Medical authorities have determined that 78° F is the healthiest temperature for recreational swimming. Colder water results in a rapid loss of body heat, especially if swimming is prolonged. Excessive pool temperature, like excessive room temperature, is a wasteful practice. Additionally, an overheated pool causes chemicals used to purify the water to evaporate more rapidly at higher temperatures, resulting in progressively larger heat losses.

14-9. SWIMMING SEASON.

The use of most heated pools is seasonal, varying in length in the different climatic zones in the country. The National Swimming Pool Institute (NSPI) recommends that a pool operator determine the length of the season based on geographic location. In this regard the pool operator should be urged to do some planning. Some operators continue to heat their pools for weeks or months after regular usage has actually ceased. It is far better, and less expensive to turn off the heater at a predetermined date than to realize that the pool had not been used for a week or even longer.

14-10. HEATERS.

Swimming pool heaters can provide comfortable water temperatures at night and during cloudy or cold weather. They can also provide auxiliary heat for pools using solar heaters and pool covers.

14-11. GAS AND OIL HEATERS.

After January 1, 1982, all new gas and oil heaters are to have a minimum 75 percent thermal efficiency compared with the previous 70 percent minimum thermal efficiency. If a heater must be replaced, the higher efficiency heater should be purchased.

14-12. ELECTRIC HEATERS.

a. Most electric pool heaters are found in areas where hydroelectric power is available; however, many are found in areas where gas was not available at the time of pool construction. In the past, cheap electric rates made them more attractive than oil- or propane-fired pool heaters.

b. Pools currently heated with electricity which is generated in substantial part by gas- or oil-fired steam-generating plants, should be under consideration for replacement with a gas- or oil-fired heater if either natural gas is available or a heating oil delivery system serves the installation. The replacement would probably be cost effective regardless of the operating condition of the electric pool heater.

14-13. ACTIVE SOLAR HEATING SYSTEMS.

a. Pool heating is the most practical, cost effective application of the sun's energy. Active solar systems can make a significant contribution to the heat required to maintain a pool at a comfortable swimming temperature. This contribution depends on the size of the collector area and its orientation toward the sun.

b. An active solar pool heating system can supply heat to pool water with only minimal use of conventional energy (that is, the energy needed to pump the water through the solar collector system). Active solar systems have been most successful as pool heating measures (approximately 93 percent of low temperature solar collector panels are used for pool heating).

c. The National Swimming Pool Institute recommends active solar systems for heating pools, where it is economical. Cost effectiveness depends upon the usage, the specific location, and many other factors. The cost of solar versus fossil or electric heating can only be compared by life cycle costing. The use of active solar panels to help heat pool water would be a commendable move in conserving non-renewable resources. Every site must be checked for adaptability for active solar. Pool solar systems usually require available panel space facing in a southwesterly (225°) direction of 75 percent to 80 percent of the pool surface area, and that space may not be shaded by tall trees or buildings. Local codes must also be checked. Reasonable planning and proper installation of solar systems nearly always results in approval.

d. An important consideration of the various economic criteria when adding a solar pool heating system is the justification of the relatively high, one-time investment in light of a payback analysis when compared to alternative methods of generating and conserving energy. With the continuing increases in fuel costs, this payback period will become more attractive.

e. It should be noted that a fossil fuel or electric heater may be required along with solar for a comfortable water temperature in a pool. For basic pool heating, the use of fossil fuels or electric heat is simply a backup to solar. However, this use allows quick heating of a swimming pool on days when the sunlight for the solar system is insufficient. (See figure 14-1.)

14-14. HEAT EXCHANGER.

When the proper chemical balance of pool water is not maintained the heat exchanger of the pool heater may become internally encrusted with scale, greatly reducing the efficiency of the heater. It is, therefore, a good conservation practice to have the heater serviced at least annually. This scaling can be minimized with the installation of a time delay timeclock (commonly known as a fireman's switch).

14-15. FUEL BURNERS.

Regular maintenance to prevent trash or leaves from blocking the burner draft ports will allow the heater to burn with the blue flame for which it was designed. Blocking the draft ports can lead to sooting and clogging of the burners, etc., and possible replacement of the burner or heater. Such blocking certainly causes the heater to burn more fuel than necessary.

14-16. WATER TEMPERATURE CONTROL.

The use of a thermostat on a pool heater is similar to the use of one for space heating and air-conditioning. Used correctly, the thermostat can save energy. Used improperly, it wastes energy.

14-17. THERMOSTAT SETTING.

a. A regularly used pool requires a thermostat setting at 70° to 80°. This setting should not be adjusted for personal preference.

b. There is less gas needed to reheat a pool for use over a weekend than is used by having the thermostat on all week to maintain a constant temperature, especially if a pool cover is not used to prevent heat loss. The amount of savings depends on the size of the pool, heater BTU rating (size), ambient temperature, humidity, wind, etc., and whether the pool is covered when not in use.

14-18. MANUAL CONTROL.

NSPI recommends that pool operators understand the

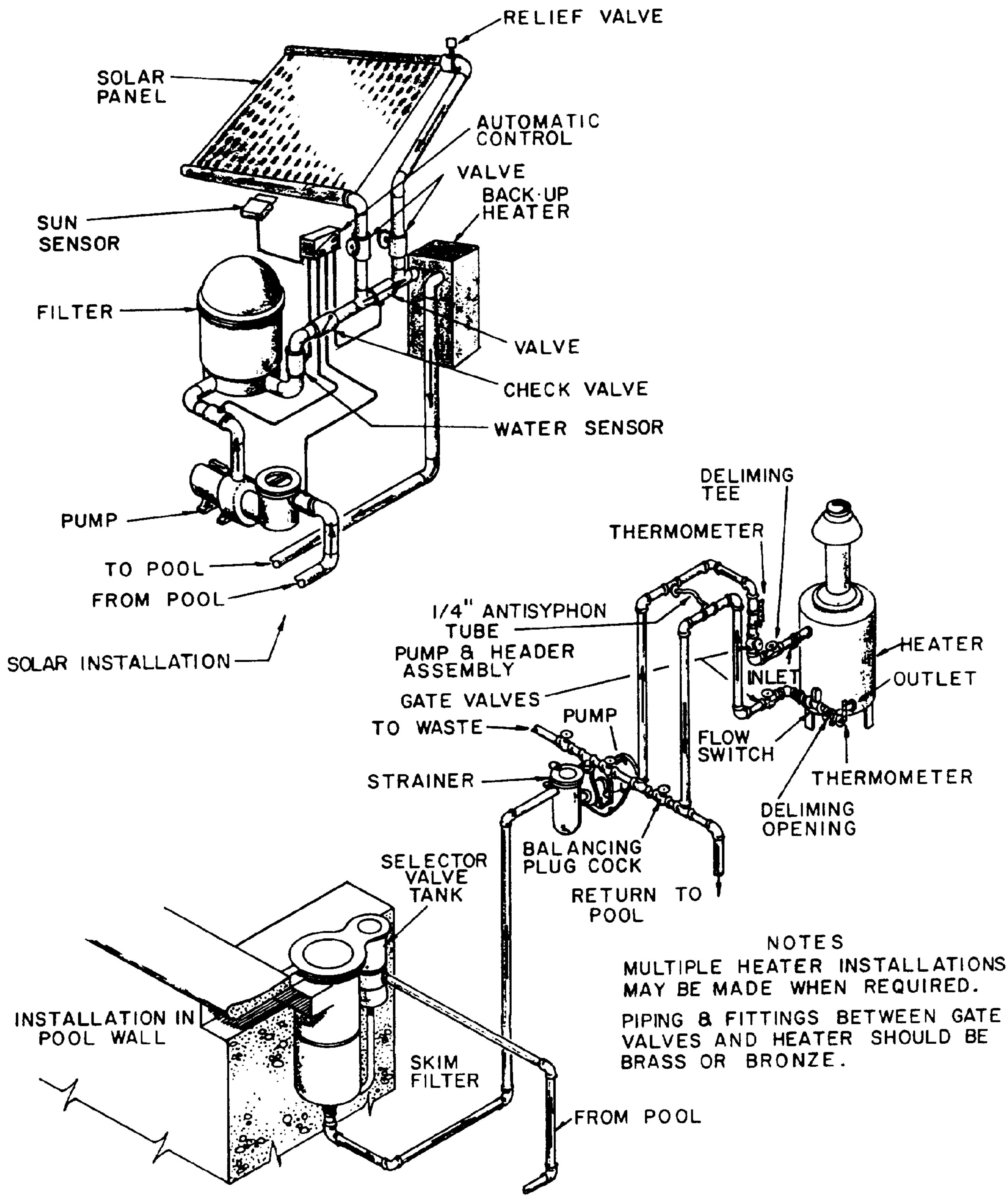

Figure 14.1. Typical swimming pool heater piping arrangement with skim type vacuum filter

use of a manual control system with the automatic thermostat on the pool heater. Pool heaters manufactured after January 1, 1981 are equipped with an on/off switch which overrides the thermostat and allows easy control for "occasional" heating. The on/off switch should allow the pool operators to turn the heater on or off without shutting off or relighting the pilot light, or adjusting the thermostat setting which can be permanently locked with a set-screw to avoid tampering.

14-19. ENERGY SAVINGS CONCEPTS.

Experience shows that energy is saved if a pool is equipped with a large, high-capacity heater to quickly bring a pool up to the desired temperature for an "occasion" and a small heater to make up the heat losses that occur during an extended heating period.

14-20. SWIMMING POOL COVERS.

Many technical papers have been written on the swimming pool as an efficient collector of available solar energy. These papers have illustrated that most of the heat lost from a swimming pool (more than 90 percent) is through the surface. The use of a pool cover prevents the waste of energy gains such as sunlight, solar collector systems, and fossil fuel or electric heaters. The swimming pool cover converts the swimming pool into a highly efficient energy storage system.

14-21. ENERGY SAVING POTENTIAL.

a. Proper use of a correctly sized and fitted pool cover can substantially reduce energy losses due to evaporation, radiation, and convection. Swimming pool water can suffer more evaporation loss than assessed through theoretical analysis. Consider the following: In summer months a swimming pool will lose an inch or more of water a week through evaporation. The heat of evaporation for water at 80° F is 1,047 Btu per pound. In a pool with a surface area of 600 square feet, 1 inch of evaporation would remove 3,121 pounds of water or nearly 3.3 million Btu's. This would cause a temperature drop of 10° F to 20° F in a 20,000-gallon pool. Evaporation is greatly affected by relative humidity and wind, which differ geographically in the United States. For example, evaporation loss is three times as great in Arizona (144 inches per year) as in Michigan (48 inches per year).

b. Thermal radiation or "black body radiation" is another major contributor to heat loss from swimming pools. Clear days and clear nights result in a major loss of radiation to the sky. In the more humid climates in the Eastern United States, much of the earth's black body radiation is absorbed by water vapor in clouds and reradiated to earth. Most studies indicate that an average of one-third of the energy from the sun is returned to space through radiation, particularly from surfaces that have emissivity near 1.00. The emissivity of water is 0.98. For that reason heat loss in a swimming pool can amount to as much as 100 Btu's per square foot per hour. This loss goes largely undetected because a body temperature of 98° F does not feel the radiation from a pool at 80° F. However, the radiated heat can be felt from a cement deck at 120° F or from asphalt or other black top surfaces.

c. By effectively limiting these heat losses from a heated swimming pool, the swimming pool cover can save 50 percent to 70 percent or even more, depending on the length of the season, of the energy used to keep the pool water at a comfortable 78° F. By far the most effective measure that a pool operator could take would be to use a pool cover.

14-22. TYPES OF POOL COVERS.

Although several types of pool covers are available, energy saving covers can be categorized into the following three types:

a. Translucent air cell
b. Insulating foam
c. Specialty

The effectiveness of each cover depends on its type and quality. There are distinct differences in their performance and energy saving capabilities.

14-23. BENEFITS OF POOL COVERS.

Quality energy saving covers should substantially reduce evaporative heat loss, water loss, and chemical consumption. Most covers will also help keep the pool clean by keeping dirt and debris out. Significant differences in these covers are based on the following three important performance characteristics:

a. Solar Transmission Value: Ability of a cover to allow natural energy from the sun to reach the pool water.

b. Insulation Value to Counter Night Heat Loss: Particularly losses from conduction and radiation.

c. Durability: Commonly measured by warranty life. Obviously, care must be exercised in the selection of a pool cover.

14-24. TRANSLUCENT AIR CELL COVER.

Characteristics of translucent air cell covers are as follows:

a. The pool cover transmits to the water at least 85 percent of the available solar energy striking it.

b. It is fabricated to prevent rainwater from collecting on the top of the cover and to prevent pool water from being exposed to the air and evaporation.

c. It is impervious to water vapor. (Should cover the entire surface of the pool in order to minimize water evaporation.)

d. It is constructed from translucent (may be tinted) ultraviolet stabilized plastic of sufficient quality and thickness to remain serviceable in normal pool usage for several years.

e. It requires no tiedowns or weights to keep the cover in place during moderate wind velocities.

f. It will substantially reduce filter operation time.

g. It provides insulation for reducing nighttime radiation and conduction heat losses.

14-25. INSULATING FOAM COVER.

The most significant qualities of the insulating foam type pool coverings are:

a. Low solar transmission severely limits the amount of sunlight transmitted to the pool water.

b. It is constructed of an insulated and nonabsorbent buoyant foam layer and an upper reinforcing layer of tear-resistant material.

c. It is fabricated to prevent rainwater from collecting on the top of the cover and to prevent pool water from being exposed to the air and evaporation.

d. It is impervious to water vapor.

e. It is manufactured with sufficient ultraviolet stabilizers to provide a service life in normal pool usage of several years.

f. Material for both layers is generally polyethylene.

g. Cover should cover the entire surface of the water to insure maximum insulation and evaporation control.

h. Requires no tiedowns or weights to keep the cover in place during moderate wind velocities.

i. It will substantially reduce filter operation time.

j. It provides insulation for reducing nighttime radiation and conduction heat losses.

14-26. SPECIALTY COVERS.

a. Specialty covers fall into three broad categories:

(1) Safety covers

(2) Automatic pool covers

(3) Winter covers

b. Safety covers normally require some form of permanent installation to allow for rigid suspension over the entire pool surface and portions of the deck areas. This type of cover screens out leaves and debris. In addition, most safety covers minimize evaporation, thus reducing both water and chemical loss.

c. Automatic pool covers require permanent installation of “slide channels” under the coping or on the pool deck. This type of cover is motor-driven, making removal and replacement simple by merely “throwing a switch.” This type of cover will reduce heat loss, keep dirt and leaves out of the pool, reduce chemical costs, and provide protection as do safety covers.

d. Both the safety type cover and the automatic type cover will retain pool heat and control water evaporation; however, both types have low solar transmission.

e. A winter cover is used to keep leaves and other debris out of the pool during the winter season.

14-27. HANDLING OF POOL COVERS.

The installation of translucent air cell covers and insulating foam covers requires only cutting and fitting to the pool shape. These covers should float on the water surface with as close a fit to the edge as possible. This avoids lifting by the wind. Specialty covers usually require professional installation. However, any operator can be taught to handle a cover alone. Some covers are fall folded; others have reel systems attached. If properly used, a cover will last several years. Most manufacturers warrant their products for several years, and useful life may exceed that by several more years with proper care, depending on geographical location and amount of ultraviolet light.